Aviation Weather Information

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NASA Ames Research Center
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http://www.zethus.larc.nasa.gov/~jayr/webpages/awin/index.htm

OUTLINE & LIST OF FIGURES

LIST OF ACRONYMS

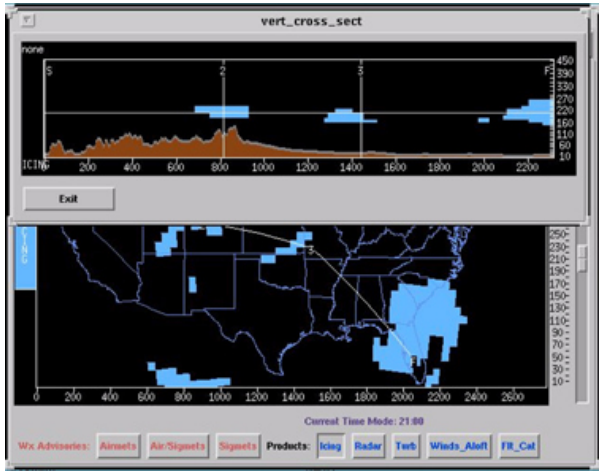
AATT	Advanced Air Transportation Technology
AGATE	Advanced General Aviation Technology Experiment
AOC	Airline Operations Center
AOPA	Aircraft Owner & Pilots Association
ARINC	Aeronautical Radio Inc.
ASIST	Safety Investment Strategy Team
AST	Advanced Subsonic Technology
ATM	Air Traffic Management
AWC	Aviation Weather Center
AWIN	Aviation Weather Information
CAT	Clear Air Turbulence
CONUS	Continental United States
CRA	Cooperative Research Agreement
DOT	Department of Transportation
EAA	Experimental Aircraft Association
EPIREPS	Electronic Pilot Reporting System
FAA	Federal Aviation Administration
FED EX	Federal Express
FMS	Flight Management System
GA	General Aviation
ISE	In-Service Evaluation
NAS	National Airspace System
NATA	National Air Transportation Research
NCAR	National Center for Atmospheric Research
NTSB	National Transportation Safety Board
NWS	National Weather Service
RTCA	Radio Technical Commission for Aeronautics
SAMA	Small Aircraft Manufactures Association
SIGET	Significant Meteorology
SITA	Society International Telecommunication Aeronautiques
TIWT	Terrain Induced Windshear and Turbulence
UAL	United Airlines
USAF	United States Air Force
VDL	VHF Data Link
VHF	Very High Frequency
WSI	Weather Systems International
W/W	World Wide
Wx	Weather

Aviation Weather Information Research Genesis

Weather is a major contributing factor in accidents

ASIST Recommendations

Priority	Investment Area
1	Data Dissemination
2	Crew/Dispatch/ATC Monitoring, Presentation, and Decision Aids
3	Icing Hazard Solutions
4	Training
5	Weather Product Generation
6	Advanced Aviation Meteorology
7	Turbulence Hazard Solutions
8	Advanced Technology Vision and Tactical Sensors/Systems
9	Near Term Tactical Sensors/Systems
10	Strategic Wake Vortex Information
11	Hazard Characterization
12	Runway Contamination



Workshops/Coordination with FAA, National Aviation Weather Strategic Plan, National Weather Service, Airline Operators, Industry, etc.

Aviation Weather Information Research

Aviation Weather Today

June 3, 1998

THE NATION'S NEWSPAPER 50 CENTS

USA TODAY

NO. 1 IN THE USA . . . FIRST IN DAILY READERS

AUTHOR'S TALE TOLD FROM THE HAMPTONS

GAINES HITS HOME IN 'PHILISTINES', 1D

TROUBLED TEENS CHART NEW COURSE FOR LIFE ON WATERS OFF BALTIMORE, 7D

WEDNESDAY

By Robert Deutsch, USA TODAY

Steven Gaines: Latest offering sold out in the Hamptons, 1D

Report: Pilots get worse weather data than public

By Fred Bayles
USA TODAY

Airline pilots aloft may know less about the weather than somebody sitting at home watching TV weather reports.

In a report issued Tuesday, the General Accounting Office said the Federal Aviation Administration still does a poor job getting crucial weather data to pilots, information that could avoid everything from bumpy flights to crashes.

The report, based on recent criticisms, said technological advances have given forecasters a better understanding of changing weather conditions, but the information is still not readily available to pilots.

"One comment made at our panel was that you can sit in the cabin of a jet with a laptop computer and get better weather information than what the pilot up front has," says Robert White, the GAO's assistant director for aviation safety.

The report said meteorologists at regional air traffic centers seldom share information with controllers nearby.

"Everyone is so focused on what they are doing that they don't have time to talk," says James Sweetman, one of the report's authors.

About 30% of air carrier accidents stem from weather problems. In general aviation, which includes small planes and corporate jets, more than 80% are caused by weather.

The FAA says it is making progress, installing 37 high tech Doppler radar units at major airports around the country.

"We agree that improving the quality of weather information is critical," says FAA spokesman Hank Price.

▶ Deadly delays, 6A

Text Printout of Convective SIGMET

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MKCC WST 221355
CONVECTIVE SIGMET 49C
VALID UNTIL 1555Z
IL IN KY
FROM IND-30SSW LOZ-60ESE FAM-IND
AREA TS MOV FROM 30030KT. TOPS ABV FL450.
CONVECTIVE SIGMET 50C
VALID UNTIL 1555Z
IL MO
FROM 20N BRL-40N DEC-50NE FAM-30N VIH-20N BRL
AREA SEV TS MOV FROM 29035KT. TOPS ABV FL450.
HAIL TO 1 IN…WIND GUSTS TO 50 KT POSS.
OUTLOOK VALID 221555-221955
FROM ORD-EKN-CLT-DYR-SGF-MKC-DSM-CID-ORD
TS CONTG TO MOVE THRU MID MS VLY/LWR OHIO VLY. AMS ALG/S OF
QSTNRY SFC FNTL BNDRY THRU CNTRL PLAINS SE TO NC CST RMNS MOIST
AND UNSTABLE. S-SWLY FLOW AT LOW LVLS INTSECTG BDRY OVR MID MIS
AND LWR OHIO VLYL HELPING TO MAINTAIN TS ACT. SOME WKNG
PSBL…HOWEVER…EXP NEW DVLPMNT IN THE 15Z TO 18Z HRS.
RFM
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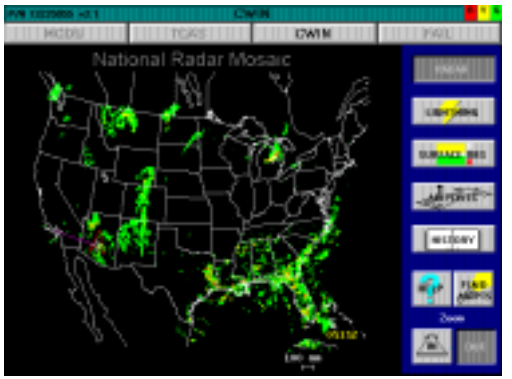
Cockpit Weather Presentation



Aviation Weather Information (AWIN)

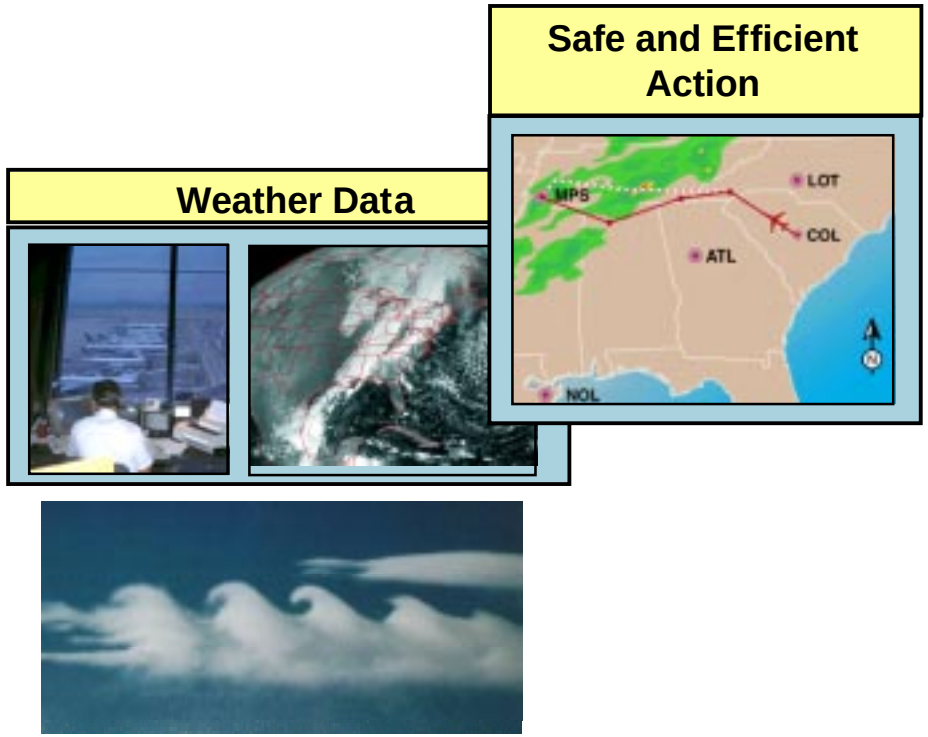
Goal

•Eliminate atmospheric hazards as a safety concern for aircraft operations in all weather conditions

Objective

•To reduce weather related accidents by enabling the development and implementation of technologies, products and systems for communicating and displaying real time weather information to airborne and groundbase users

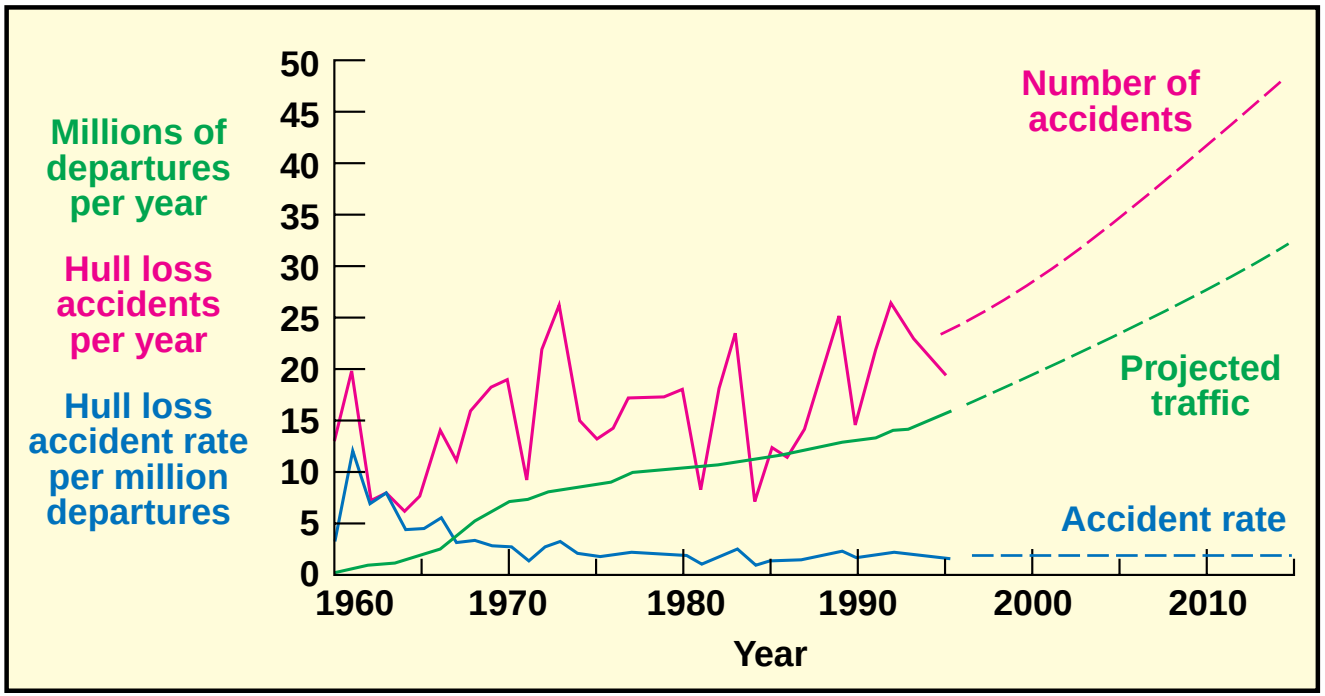
•Develop technologies for and facilitate operational implementation of airborne clear air turbulence mitigation system

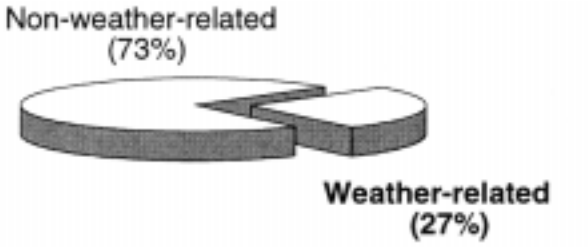


Level 1 Milestone	Output Metric	Outcome
Define and evaluate operational concepts for all-weather turbulence detection systems (4QFY99)	Quality and breadth of flight test database	Reduced CAT accidents and incidents
Evaluate and select Aviation Weather Information (AWIN) concepts (4QFY99)	Focus and quality of specification for system design	Reduced weather-related accidents

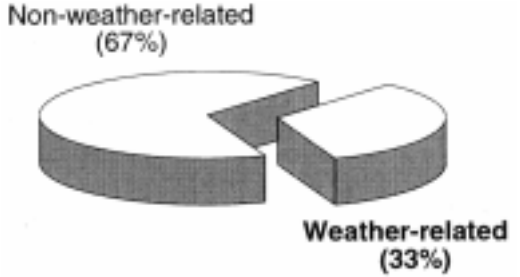
Project Benefits

Accident Rate Projections





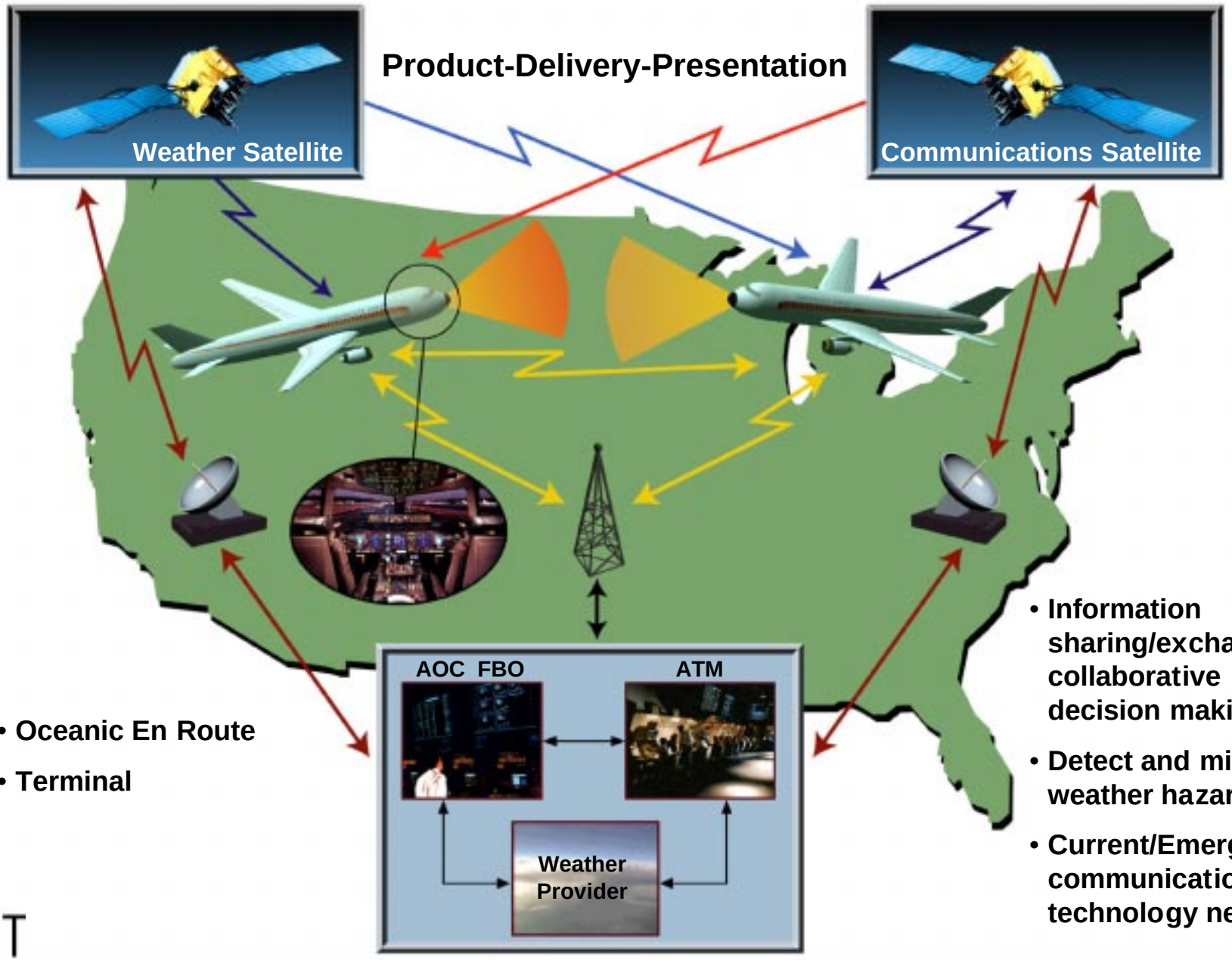
GA Aviation Accidents 1982-1993
(22,053 total accidents)
Source: AOPA Air Safety Foundation



Commercial Carrier Accidents
1983-1995
Source: NTSB

Project Approach

AWIN



- Oceanic En Route
- Terminal

- Information sharing/exchange for collaborative decision making
- Detect and mitigate weather hazards
- Current/Emerging communications technology network

AWIN Distribution and Presentation Sub Element Approach

Operator Support

Safe and Efficient Action

Terrain Obstacles Air Space Traffic

Decision

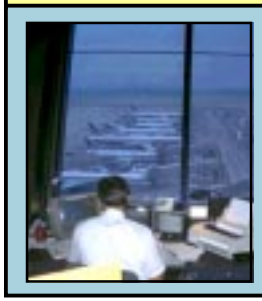
Information Presentation

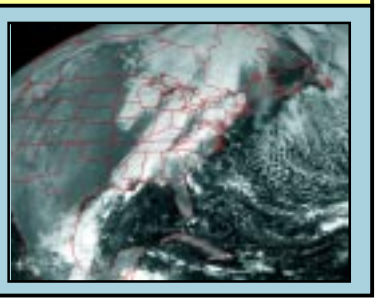
Processor

Database

Aircraft Capabilities

Enhanced Weather Products

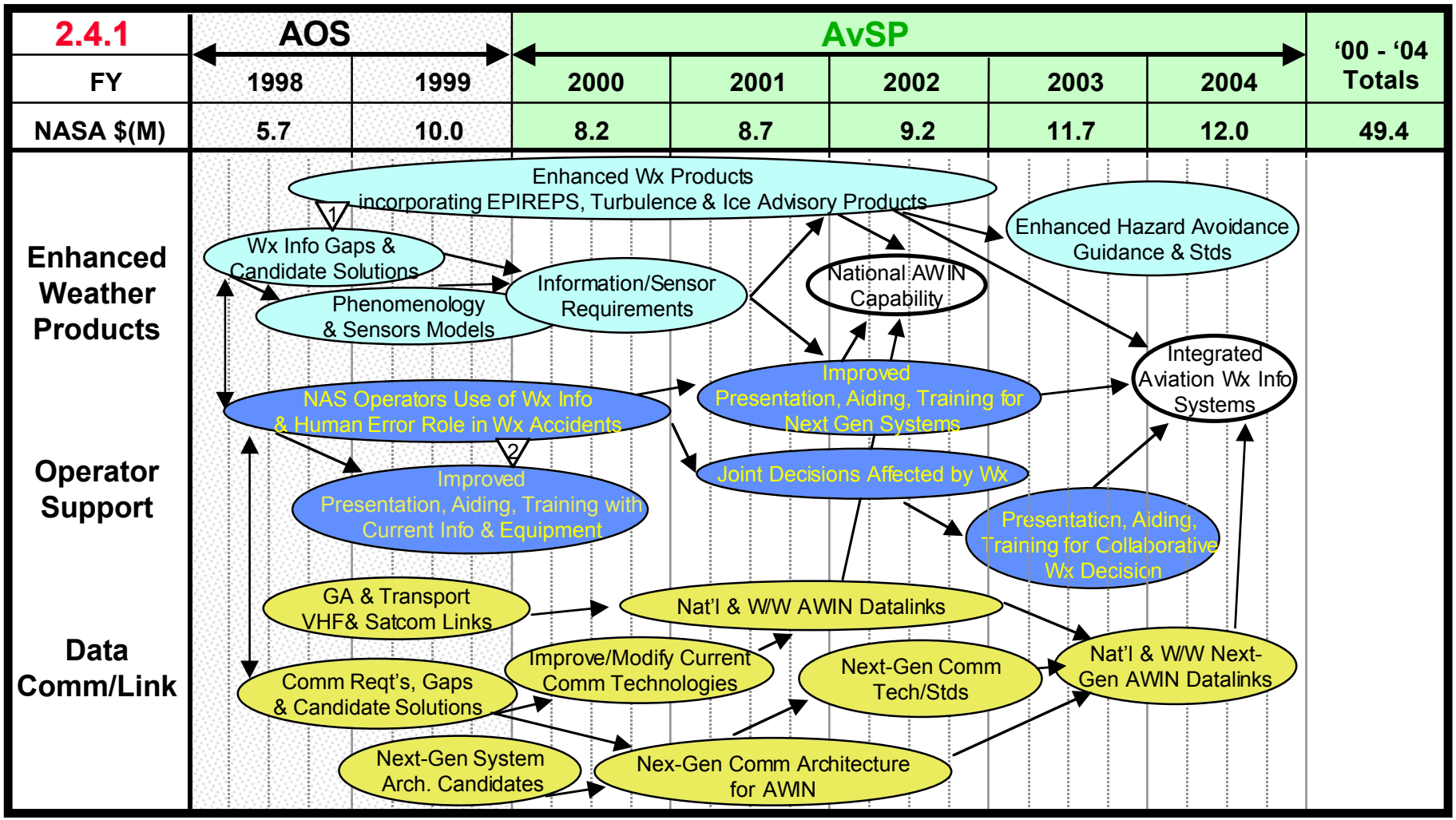




Data Communications/Link

- Provide the Flight Deck ATM &AOC with Higher Fidelity, More Timely Intuitive Graphical Information
- For all classes of Aircraft
- Requirements/data driven approach

AWIN Distribution and Presentation Sub Element Roadmap



1) Aviation Weather Information System concepts selected for evaluation

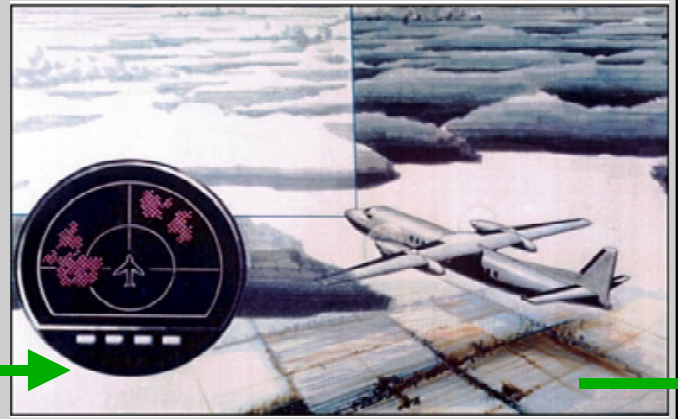
2) Evaluate and select Aviation Weather Information concepts

Turbulence Sub-Element Approach

AWIN

Detection

- Sensor Performance Assessment
- Sensor Utilization & Development
- Turbulence Modeling



NCAR Electra

- Algorithm Development
- Demonstration & Verification
- Hazard Metric Development

Turbulence Characterization

JAL Boeing 747

- Severe Events Database
- Assessment of Existing Turbulence Products

Forecasting/Nowcasting

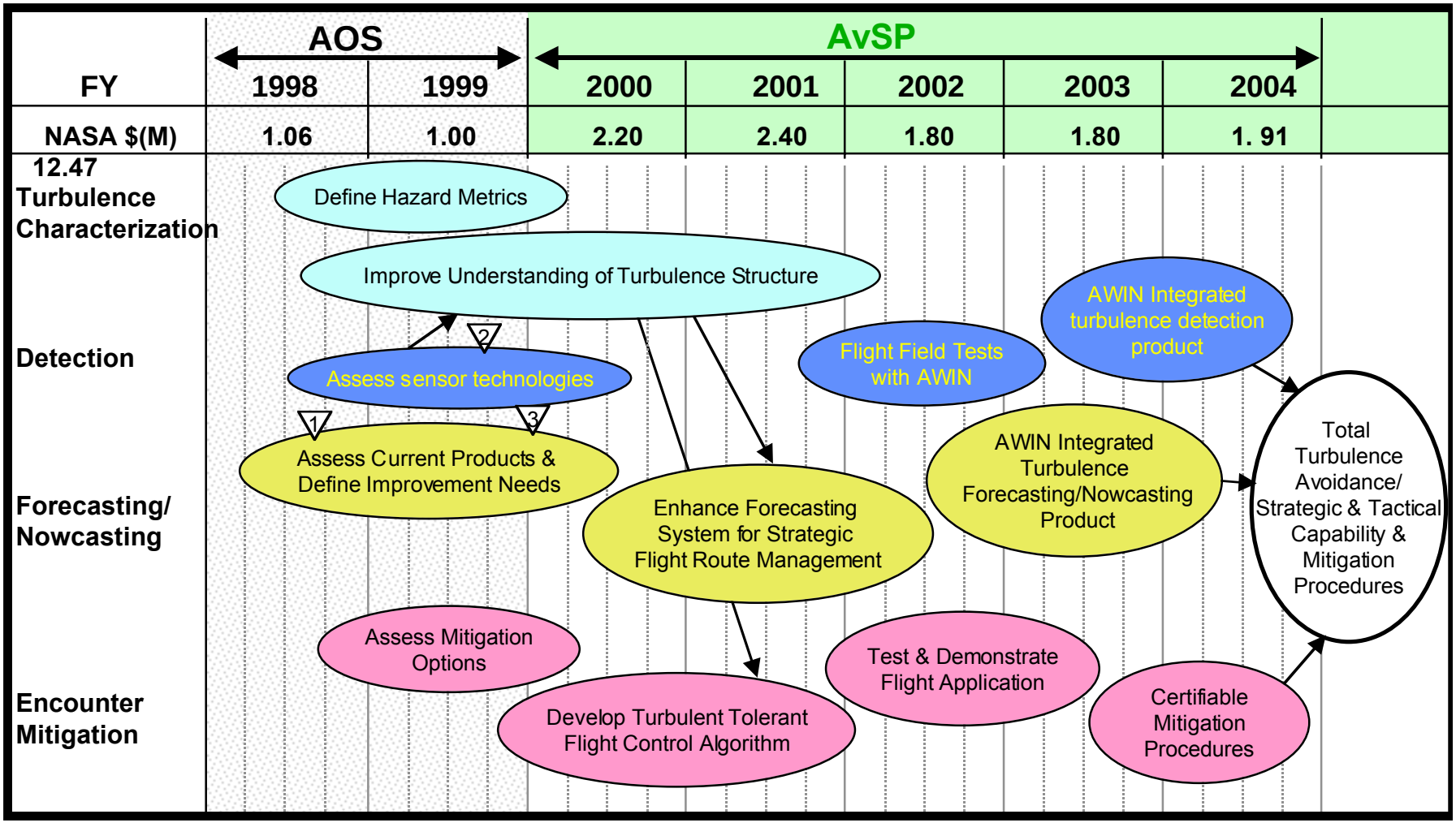
Turbulence Map

Mitigation

Advanced Cockpit

- Turbulent Tolerant Flt. Control Algorithm
- Demonstration & Verification
- Strategic Route Management

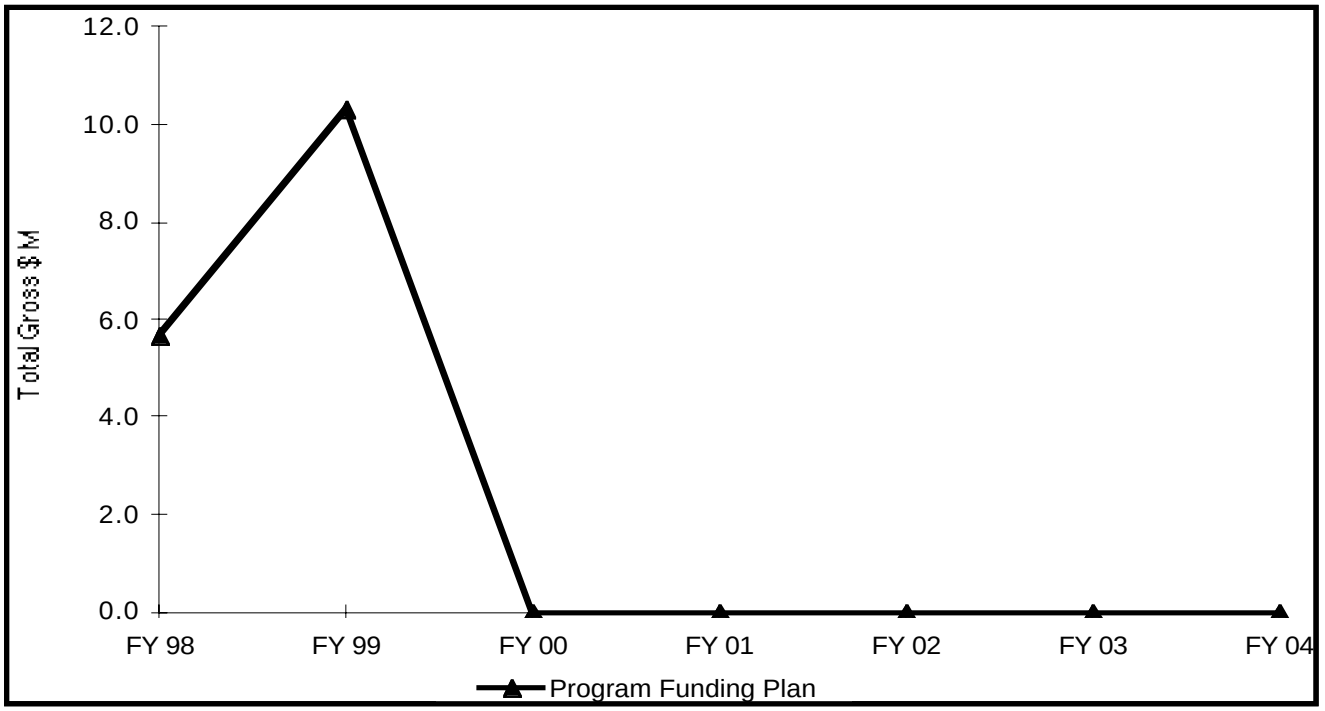
Turbulence Detection & Mitigation Sub-Element Roadmap



1) Flight Evaluation of a Lidar on-board forward looking turbulence detection system
2) Evaluate current technology detection capability
3) Define and evaluate operational concepts for all-weather turbulence detection systems

PROGRAM FUNDING PLAN

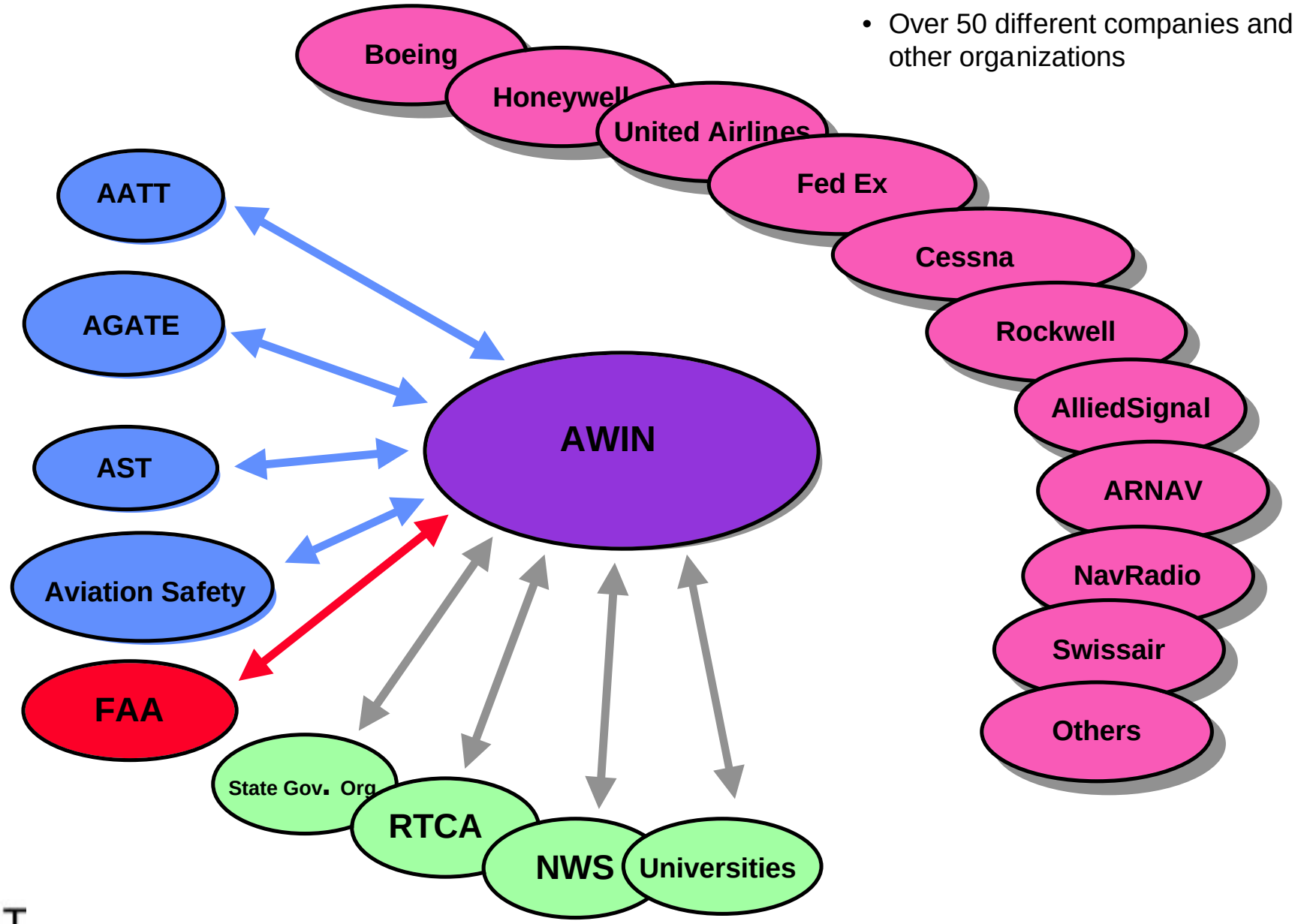
Aviation Weather Information (AWIN)



Program Funding Plan	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	Total
Net Totals	3.6	7.2	0.0	0.0	0.0	0.0	0.0	10.8
Program Support	2.1	3.1	0.0	0.0	0.0	0.0	0.0	5.2
Total (Gross)	5.7	10.3	0.0	0.0	0.0	0.0	0.0	16.0

Outside Relationships

- Over 50 different companies and other organizations



Technology Transfer and Deliverables

Proposed TEAM	Problem	Products	AOS Investment 98-99, $M
Honeywell, ARINC, WSI, NCAR, AlliedSignal, UAL, COMSAT, Kavouras, Swissair, SITA, NWS/AWC.	Worldwide weather info network	• Strategic/tactical airborne displays • Airborne and ground based servers • Multiple providers of weather products and data link services	2.4
Boeing, Federal Express, General Dynamics, Canadian Marconi Corporation, COMSAT, Weather Services International (WSI), NCAR, Honeywell, Rockwell, FAA, and USAF.	Inflight testbed facility.	• FedEx MD-11 in service evaluation aircraft flying commercial routes worldwide (initial flights in FY99). • Collection and analysis of inflight data on current / advanced weather products.	2.0
NavRadio - Aspen Mountain Airlines, **Atmospheric Systems, Avidyne, AvroTec,** EAA, FAA CAMI, Mn/DOT, NAFI, PA/DOT, Raytheon Electronics, RAA, **Seagull Technology, Unisys WIS,** WI/DOT.	Early implementation of an affordable, flight information system for GA airplanes (by FY99).	• Open architecture flight information system (FIS) • Operating ground station network • Multiple experimental aircraft with datalink, displays and software. • Airborne System Certification Plan for displays.	1.2
ARNAV, NCAR, Cessna, EAA, NATA, SAMA.	Immediate deployment of advanced graphical weather displays for GA aircraft.	Flight eval of 4 advanced NCAR weather products : • National convective hazard product • Integrated airborne icing product • Integrated turbulence product • Aviation gridded forecast system	0.4
Rockwell Science Center, Rockwell Avionics & Communications, University of Illinois. (Leverages: AGATE, IR&D, Army Research Labs, Boeing IR&D, USAF)	Integrating many weather sources/presentations into one format.	• Web based preflight briefing system (FY99) • PC-based onboard tactical system presented on electronic flight information systems display (FY02)	0.4

Technology Transfer and Deliverables

Proposed TEAM	Problem	Products	AOS Investment 98-99, $M
Rockwell Science Center, Rockwell Avionics & Communications, Research Triangle Institute. (Leverages: AGATE, IR&D, Army Research Labs, Boeing IR&D, USAF)	Using weather sensing equipment and interpreting weather information.	Web based demo system.	0.4
Honeywell Technology Center (WorldNav CNS/ATM team)	Strategic route optimization to avoid weather hazards	Enhancements to existing and currently evolving products. Production equipment ready in late 1999	0.4
NavRadio, Aspen Mountain Airlines, Atmospheric Systems, Avidyne, AvroTec, D-TEK, EAA CAMI, Inertia Tech, NCAR, RAA, Seagull Technology, Mn/DOT, WI/DOT, Unisys WIS	GA airplanes enhanced electronic PIREP system.	• New datalink capability sends weather data from airborne GA sensors to ground receivers for dissemination. • Prototype and production airborne equipment packages • datalink range testing • Equipment installed in 15 aircraft for flight tests.	0.4
AeroTech Research, NCAR,	Turbulence Characterization	• Hazard Metrics • Preliminary assessment of turbulence hazards	.4
AlliedSignal, Rockwell, CTI, UCAR, NCAR	All weather turbulence detection and mitigation	• Radar models, simulations and flight test results • Concepts for all weather detection	1.0

FY98/99 Accomplishments

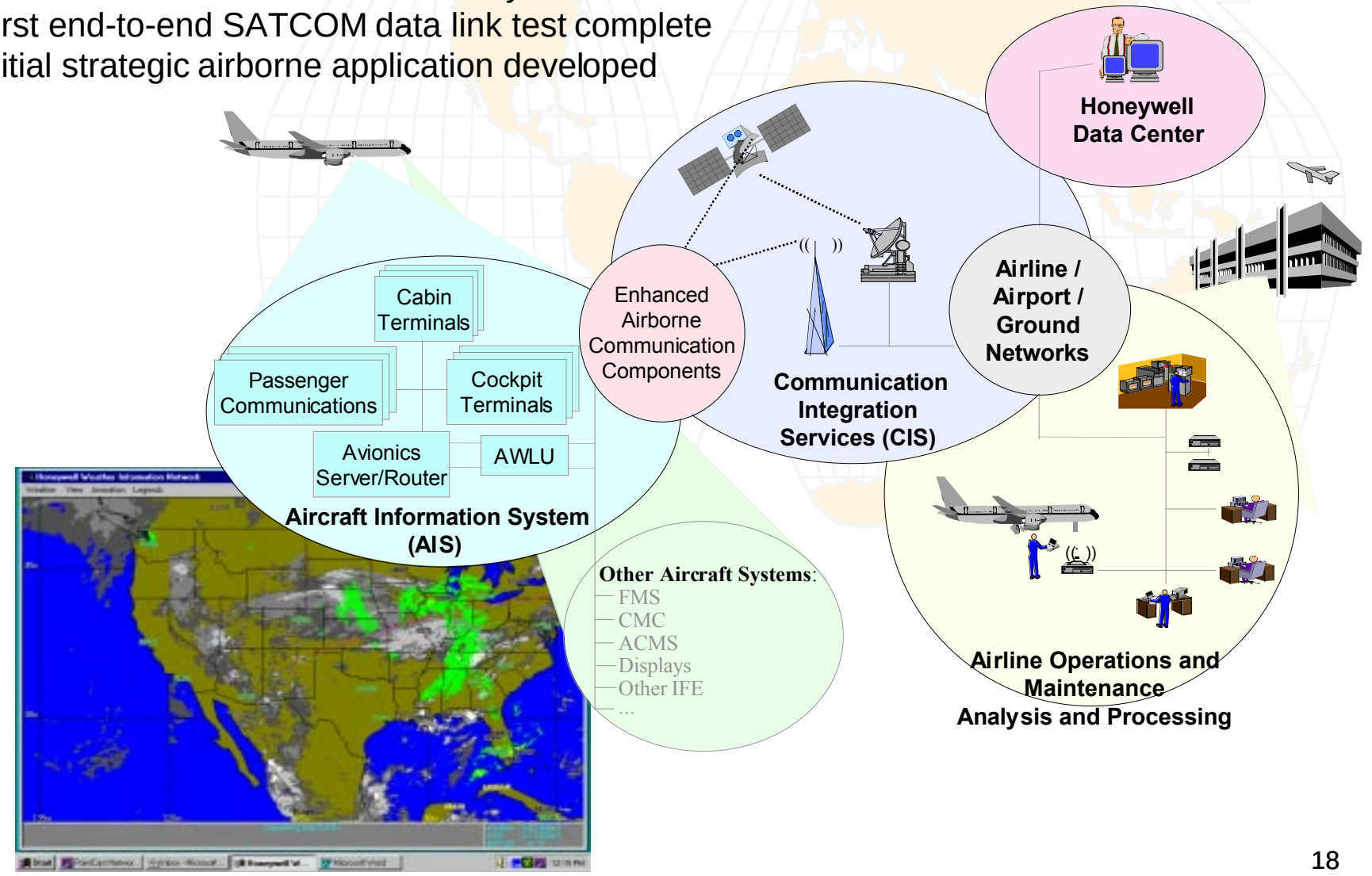
In-Service Evaluation (ISE) of AWIN System for Transports (CRA with Boeing)

- Aero-H Satcom, AWIN processor & display hardware installed on FedEx MD-11
- Nat'l Wx product packaging 90-100% completed, ground & airborne hardware installed
- AWIN ISE on FedEx MD-11 scheduled to start in Q1 CY99 for CONUS; ISE over North Pacific scheduled to start by Q3 CY99

Total Aircraft Information System

AWIN

- Preliminary design complete End-to-End Architecture
- Communications provider contract finalized to provide world wide coverage
- Live weather data received at Honeywell
- First end-to-end SATCOM data link test complete
- Initial strategic airborne application developed



FY98/99 Accomplishments - General Aviation

- **Development of a Weather Hazard Information System (CRA with ARNAV)**
  - Text and graphical weather products including new turbulence & icing forecasts
  - Cessna 182, 208, 210, T-47 aircraft equipped with data link/display equipment
  - New AWIN Wx products added to ARNAV network
  - Flight tests now underway (400 hrs by 4Q99)

ARNAV

SAMA

NCAR National Center for Atmospheric Research
University Corporation for Atmospheric Research

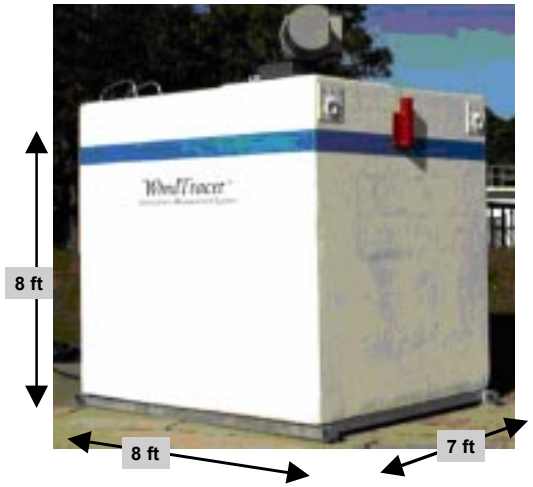
EAA

Cessna
A Textron Company

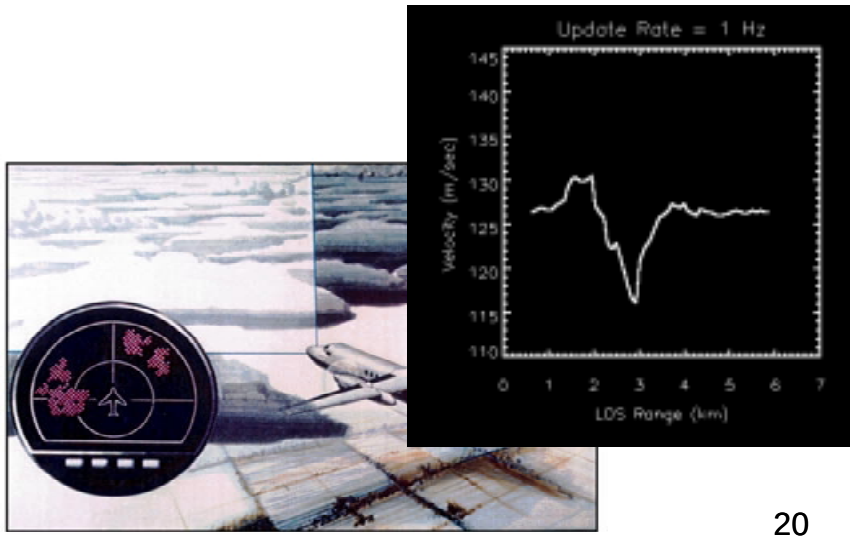
- **Development of an Open Architecture VDL Mode 2 Based Regional AWIN System (CRA with NavRadio)**
  - Low-cost, self-contained ground stations co-located with AWOS sites
  - Ground-based broadcast at 31.5 Kbps; airborne displays from multiple vendors
  - 43 ground stations across Northeast U.S.; 32 equipped GA aircraft
  - Detailed system designs, deployment underway

Accomplishments

- **Brought Lidar sensor to Juneau for wind field measurements**
  - For strong wind 'events', generated database for characterizing severe low altitude windshear and turbulence (FAA)
  - Mapped terrain-induced windshear and turbulence (TIWT) flows in and around airport (FAA)
  - Generated validated data sets to support development of lidar turbulence and windshear detection algorithms (NASA)



- **Flight Evaluation of a Lidar On-Board Forward-Looking Turbulence Detection system**
  - Detected light to moderate turbulence at ranges between 3 and 6 miles ahead of aircraft
  - Penetrated turbulence to verify
  - Operated 15 hours in a variety of aerosol conditions and atmospheric moisture at altitudes from ground to 25k ft.



Facility Utilization

FY98 & FY99

- **LaRC Transport Research Facility (LaRC)**
- **Convair 540 (Allied Signal) or DC-8 (DFRC)**

Project Assessment

	3Q98	4Q98	1Q99	Remarks
Program Overall Assessment	G	G	G	
Technical Performance	G	G	G	
Cost	G	G	G	
Schedule	Y	G	G	

Guidance:

Assessment & Performance	L2 Judgement
Cost	-5% Yellow -15% Red
Schedule	-1Q Yellow -2Q Red

Future FY 99 Activities

- Establish a Turbulence RTCA Special Committee to define and maintain operational requirements
- Identify weather product gaps customized to aviation weather needs
- Collaborating with weather radar manufacturers to develop and evaluate an enhanced radar mode for the detection of convective turbulence using on-board wind shear weather radar.
    - Expected initial target fleet deployment within 2 years
- Assessment of Low cost Satellite communications
- Improve cockpit presentation and provide decision support tools
- Demonstrate and evaluate integrated weather information system for General Aviation and National/World Wide commercial aviation communities
- Perform flight evaluation of Globalstar SATCOM antennas for G/A datalink applications
- AWIN ISE on USAF “Speckled Trout” and NC-21 (Learjet 35) aircraft planned as additional flight evaluations

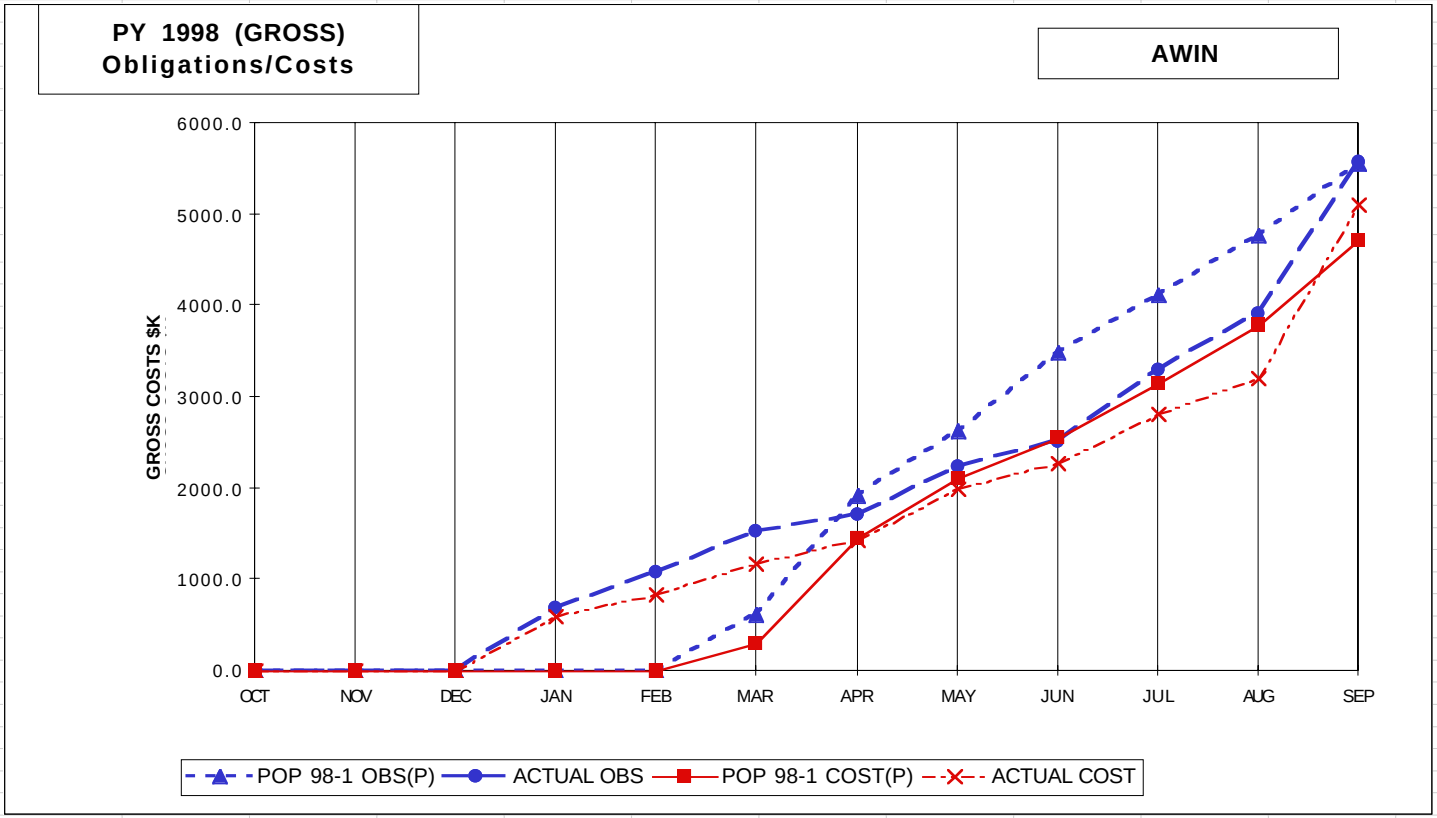
SUMMARY

Weather is a factor in approximately 30% of aviation accidents

- Created Government/Industry partnerships to enable the National Airspace System "Weather Channel"
  - Early implementation of commercially viable AWIN systems appears to be feasible
  - Eight research agreements have been implemented involving over 40 industry, university and government entities
- Comprehensive plan for all weather turbulence detection and mitigation has been developed in cooperation with the FAA and industry
  - Initial concepts flight tested
  - RTCA Special Committee being developed and implemented
- Advanced Communication requirements being developed
- On schedule to meet level 1 milestones and transition technology development to AvSP

Financial Performance

AWIN



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NOP 98-N PLAN												
POP 98-1 OBS(P)						617.0	1927.0	2628.0	3478.0	4118.0	4774.0	5558.0
ACTUAL OBS				687.0	1082.0	1525.0	1715.0	2241.0	2517.0	3297.0	3920.0	5572.0
VARIANCE				687.0	1082.0	908.0	-212.0	-387.0	-961.0	-821.0	-854.0	14.0
POP 98-1 COST(P						292.0	1450.0	2104.0	2550.0	3153.0	3789.0	4711.0
ACTUAL COST				599.0	845.0	1182.0	1433.0	1989.0	2282.0	2819.0	3214.0	5101.0
VARIANCE				599.0	845.0	890.0	-17.0	-115.0	-268.0	-334.0	-575.0	390.0